

NANOTECHNOLOGY AND ENVIRONMENTAL POLICY: ANALYSIS OF FUNDING AND OUTCOMES

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RESEARCH OBJECTIVES

Nanotechnology and nanoscience can lead to great advances in many fields, and the potential revolutions they may bring to medicine, energy systems, and information technology have been widely publicized. However, the potential societal and environmental implications are a growing concern. There have been a few recent reports that initiate the discussion of environmental impact, but these are not yet comprehensive or conclusive. This work analyzes the National Nanotechnology Initiative (NNI) funding related to the environmental impact of nanotechnology and the research outcomes in this area.

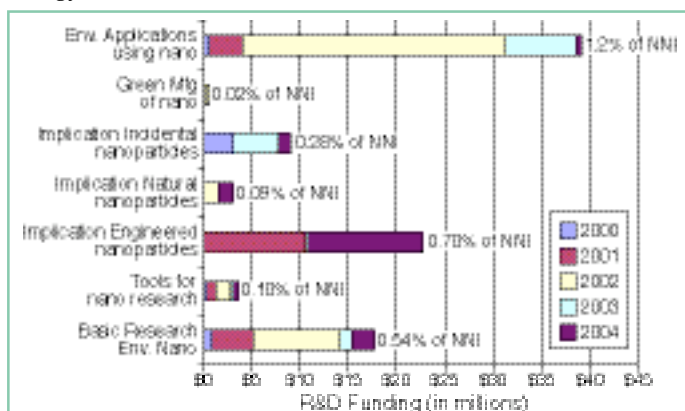


Figure 1. Estimated NNI environmental research, 2000–2004. These preliminary results include an overestimate of funding in the “implication of engineered nanoparticles” area.

APPROACH

We use an ecosystem approach to define “environmental impact” such that it encompasses positive, negative, and neutral effects on soil, air, water, plants, animals (including humans), and other organisms. We obtained data from several sources: agency websites, interviews with agency representatives, and the NNI website. All funding data were assigned a coded category, shown in Figure 1. To code funding data, we reviewed the available title, abstract, and progress-report data on individual grants, and categorized these grants by research topic. In some instances, the principal investigators of the grants were contacted to identify the distribution of the awards by category.

ACCOMPLISHMENTS

We analyzed the NNI funding data for nanotechnology and the environment from 2000–2004 cumulatively, as well as by year and agency, as shown in Figure 1. Preliminary estimates indicate that funding to date in all environmental nanotechnology studies is only 2.9% of the \$3.26 billion of federal grant money coordinated by the NNI in this period. This environmental nanotechnology funding is heavily weighted towards “environmental applications of nanotechnology,” or the positive environmental uses of

nanotechnology. “Implication of engineered nanoparticles” received a little over half of the overall funding for positive environmental applications, but includes a significant funding increase in 2004.

We also analyzed the published research on environmental implications of nanotechnology. Toxicity of nanosized aerosol particles and carbon fullerenes has been discussed in the literature for a number of years prior to the establishment of the NNI. Recent studies on nanotechnology impact are limited, and focus on the toxicity of nanoparticles such as cadmium selenide, carbon nanotubes, and fullerenes. Limited studies on nanoparticle exposure and transport of nanoparticles also have been published. Many of the studies cite enhanced toxicity or anomalous behavior at the nanoscale, reinforcing the need to investigate the unique impact of nanosized particles on all aspects of the environment.

SIGNIFICANCE OF FINDINGS

Funding priorities for environmental nanotechnology do not yet appear to have stabilized. This situation is likely to be the result of shifting “top-down” considerations of the environmental issues related to nanotechnology by government officials. It is important, however, to consider the influence that “bottom-up” factors have had on this result, because the ultimate distribution of funds according to topic area must reflect the proposed research of scientists applying for NNI environmental grants. The limited published studies on the overall environmental impact of nanotechnology demonstrate that there are many interesting and vital studies to be conducted in this area.

RELATED PUBLICATIONS

- Banfield, J.F., and H. Zhang, Nanoparticles in the environment. In: *Nanoparticles and The Environment: Reviews in Mineralogy and Geochemistry*, J.F. Banfield and A. Navrotsky, eds., 44, 1–59, 2001.
- Taylor, M.R., E.S. Rubin, and D.A. Hounshell, Stimulating environmental technological innovation: Government actions and SO₂ control technology. *Technological Forecasting and Social Change*, November 2004.

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